

Assessment of the of fixed dental prosthesis impressions received at commercial dental laboratories in Aljabal-Alakhdar region, Libya

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DOI: <http://doi.org/10.38177/AJBSR.2024.6111>

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Article Received: 25 December 2023

Article Accepted: 27 February 2024

Article Published: 20 March 2024



ABSTRACT

Background: Crown and bridge prosthodontics needs an accurate and precise impression (positive replica) of the abutment teeth and the edentulous region to be rehabilitated for the dental technician to be able to construct the high quality and well adapted fixed dental restoration without mistakes. The aim of the current survey was to assess any visible mistakes commonly observed in fixed dental prosthesis impressions received at five commercial dental laboratories, frequency errors determination, and to determine any possible association between the preparation finish line errors and other assessed factors.

Materials and methods: 150 fixed prosthodontic impressions were collected from five commercial dental laboratories located at Aljabal-Alakhdar region, Libya. All the fixed prosthodontic impressions which had been received by the visited commercial dental laboratories were assessed for many factors in relation to the accuracy such as the dental arch involved, prepared abutment teeth, dental impression materials used, and final techniques and viscosity of the impression, the type of impression tray, full-arch or segmental impression tray, the impression tray size, type of fixed dental restoration requested, mistakes in impression material or tray used, gingival tissue dilation errors, closed-mouth impression technique errors, and finish line errors. No attempts were made to determine the reason of the detected errors in each fixed prosthodontic impression assessed. Association between dental practitioner years of experience and gender and impression errors was evaluated. The association between categorical variables and the outcomes were examined by the use of Chi square and Fisher exact tests.

Results: Condensation silicone was the most impression material used. Of the impressions evaluated 121(80.6%), 97% have at least one detectable error, 103(68.6%) had finish line errors, 53.9% had tooth preparation area errors. Visible contamination of impression with blood was seen in about 79(52.2%) of the assessed impressions. There was significant association between the type of dental impression material and errors in the preparation cervical finish line and tooth preparation area.

Conclusion: In the present study, it has been found that a high frequency of recognizable errors was detected in crown and bridge impressions received by the five commercial dental laboratories. This can result in poorly fitted fixed restorations cemented for the fixed prosthodontic patients.

Keywords: Fixed dental restoration; Crown and bridge impressions; Dental laboratories; Accuracy; Aljabal-Alakhdar; Libya.

1. Introduction

The sending of exact fixed prosthodontic registrations to the dental technician is an essential aspect of fixed restoration construction in crown and bridge work. Achieving an accurate displacement of the gum and an excellent negative replica of the prepared teeth and edentulous ridge for crowns and bridges is the most important challenging aspects in fixed prosthodontics. Although many clinical and laboratory procedures should be made for the fabrication of an indirect cast fixed dental prosthesis where a lot of mistakes can arise during this period the dental laboratory technician can be expected to fabricate a high quality fixed dental prosthesis only if the received fixed prosthodontic impression is of high accuracy. All dental practitioners must obtain the ability to identify and analyze the accuracy of crown and bridge impressions because this ultimately will lead to accurate fixed dental prosthesis. The dental literature is limited in studies directly evaluating the quality of impressions for crowns and bridges in Aljabal-Alakhdar region, Libya. The purpose of our survey was to evaluate the accuracy of impressions for crown and bridge work sent to commercial dental laboratories by describing the frequency of clinically detectable errors and by analyzing association between the various factors involved. Good impression accurately captures the details of the oral cavity, including preparation margins, soft tissue, and occlusal surfaces, while the bad impression gives incomplete or distorted details which can compromise the fit and function of the definitive prostheses. The final

impressions in the field of fixed prosthodontics can be made by the following techniques: 1) Single-mix impression technique. 2) Double-mix one step impression technique. 3) Double-mix two step (putty/wash) impression technique. 4) Closed mouth impression technique. The impression tray is a device that is used to carry, confine, and control impression material while making an impression. Crown and bridge impressions can be classified into full dental arch impressions and sectional dental arch impressions. Different types of impression trays are used for registering fixed dental prosthesis impression: 1) Prefabricated or stock trays (full-arch or sectional). 2) Custom-made trays, and dual arch trays (full-arch and sectional) with the elastomeric impression materials. The most difficult fixed prosthodontic procedure so far is to achieve proper gingival tissue retraction and an accurate impression. It is very important for the dental practitioners to evaluate their fixed prosthodontic impression prior to sending them to the dental technician. In Aljabal-Alakhdar region, no investigation so far has been conducted to assess the accuracy of crown and bridge impressions and for this reason, the collected impressions were examined to determine their accuracy.

2. Materials and Methods

The current survey was an observational cross-sectional investigation assessing the accuracy of fixed dental prosthesis impressions sent to commercial dental laboratories for the construction of fixed dental prostheses. This survey has been performed from September 2023 to January 2024. The examiners assessed all the fixed prosthodontic impressions for errors by using $\times 2.5$ magnification loupes under ambient room lighting without the aid of any additional illumination. The authors visited 5 commercial dental laboratories located at Aljabal-Alakhdar region, Libya. These five commercial dental laboratories were chosen because they used to receive many crown and bridge impressions and deals with many dental practitioners.

All fixed dental prosthesis impressions received for fabrication of crowns and bridges were assessed without selection or rejection. Impressions for resin-bonded fixed partial dentures, veneers, and implant abutments have been excluded. All the received impression have been disinfected prior to their assessment but before pouring them with high-strength dental stone. 150 fixed prosthodontic impressions were collected and evaluated. Whenever, there are many abutment teeth registered in a single dental impression, defect on any abutment tooth was regarded as an error for the whole impression.

The examination and assessment of the collected fixed prosthodontic impressions were performed against criteria laid out in a custom-designed impression evaluation form. The dental arch in which the fixed dental prosthesis to be fabricated, number of prepared teeth, type of dental impression materials, final impression techniques and viscosity in case of rubber-based impressions, type of impression tray, size of the impression tray, and type of fixed dental prosthesis requested were documented. Errors in finish line, in teeth preparation area, presence of blood contamination in impression and errors in elastomeric impression technique were also documented. Also the defects in dental impression material polymerization, tissue contact by tray, adhesion (retention) to the impression tray, exposure of the heavy-bodied impression material exposure through the "reline" material (for double-step impressions), and tears, bubbles, or voids, or tears along the finish line or preparation area were also recorded. Only the received fixed dental prosthesis impressions have been evaluated no attempt have been made to assess the

working casts or the fixed dental restoration to be fabricated. Both the adhesion of dental impression materials to the tray as well as the displacement of the gingival tissue were recorded as adequate or inadequate. We gathered all the data related to the dental practitioners who have taken the fixed dental prosthesis impressions from was taken from the commercial dental laboratories. No doubt, this data was helpful for relating the detected mistakes to the dentist's gender and experience years. There was no attempt to know neither the dentist name nor the identification of the dental offices from which the impressions have been received. To prevent the bias evaluations the identities of the dental practitioners were kept unknown to the examiners. Data analysis was performed using SPSS 20 for Windows. The collected data were presented using frequency tables. The presence of any association between the gender of dental practitioners and years of experience, and impression mistakes has been evaluated.

3. Results

The aim of this analysis was to describe the frequencies of the assessed factors and to detect the presence of any association between an error of the preparation margin with the other factors assessed. Out of the 150 fixed prosthodontic impressions examined and evaluated, 55(36.7%) were mandibular impressions and 95(63.3%) were maxillary impressions. Full arch trays were 143(95.3%). The used impression materials were as follows: 20(13.3%) irreversible hydrocolloid impression material, 121(80.6%) condensation silicone rubber base impression material and 9(6%) polyvinyl siloxane rubber base impression material. Plastic stock "pre-fabricated" impression trays were 136(89.3%) while the metal stock tray was 12(7.9%). Out of the 150 evaluated impressions, 76(50.6%) have 4 or more abutment teeth, 33(22%) have 2 abutment teeth, 19(12.6%) have one prepared tooth and 22(14.6%) have 3 abutment teeth. The received and evaluated 150 fixed prosthodontic impressions in the study are from 150 dentists, 103(68.6%) was male, 47(31.4%) was female. Regarding the experience years, 111(74%) had ≤ 10 years and 39 (26%) had more than 10-year experience.

Bubbles in preparation finish line were the most common error 40(26.6%), followed by voids 18(12%). In general, 103(68.6%) of the assessed impressions had defects in the cervical margin as shown in Table 1. Of the fixed prosthodontic impressions which have been evaluated, 59.3% had defects in the teeth preparation area.

Table 1. Errors of fixed prosthodontic impressions

Errors of fixed prosthodontic impressions	Frequency (F)	Percentage (%)
Type of defect (error) in the preparation cervical margin (finish line)		
Voids in cervical margin of the prepared teeth	32	21.3%
Bubbles in the cervical margin of the prepared teeth	54	36%
Tear in the tooth preparation finish line	3	2%
Presence of gingival tissue over the tooth preparation cervical margin	6	4%
Fold or pull in the tooth preparation cervical margin	8	5.4%
Inadequate gingival tissue displacement (retraction)	55	36.6%

Type of defect in the area of tooth preparation		
Presence of voids in the area of tooth preparation	18	12%
Presence of air bubbles in the area of tooth preparation	40	26.6%
Exposure of the impression tray in the area of tooth preparation	13	8.6%
Lack of fine details of the crown and bridge impression	18	12%
Decrease in the adhesion of the restorative impression material to the impression tray	33	22%
Presence of blood in the impression	79	52.2%

Out of 130 elastomeric impression materials, 111(74%) was a single-step final impression technique and 39(26%) was a double step final impression technique. The most common final impression technique was putty-reline impression technique.

Table 2. Defects of elastomeric rubber base impression techniques

Type of errors of silicone impression technique	Frequency (F)	Percentage (%)
The number of the evaluated impressions contained defects	99	66%
Incomplete mixing of the dental impression materials	3	2%
Stepped impression	15	10%
Absence of light-body impression material in the cervical margin of the teeth preparation in finish line area	13	8.7%
Exposure of the heavy-body impression material through the light-body "wash" material	40	26.6%
insufficient adhesion of the dental impression materials to impression tray	20	13.3%
incomplete polymerization of the dental impression materials	8	5.3%

Table 3. Frequencies and description of unacceptable error criteria

Criterion	Error Description	Frequency (No. (%))
Presence of bubbles or voids in the preparation cervical margin.	Any recognizable bubbles or voids on the preparation margin.	86(57.3%)
Absence of wash/reline impression material in the preparation finish line.	The tooth preparation cervical margin registered in the putty elastomeric impression material without any wash material either below or above the cervical margin.	13(8.7%)

Inadequate adhesion (retention) of impression material to the impression tray.	Impression material pulling away of the impression material from the impression tray or there is no engagement into the impression tray retention features.	20(13.3%)
The impression tray is pressing on soft tissue.	Exposure of the impression tray flanges caused by dental impression material displacement.	13(8.6%)
Showing of the impression tray through of incisal edges or occlusal surface.	Exposure of the horizontal impression tray areas due to displacement of the dental impression material.	17(11.3%)
Presence of inadequate fusion of Viscosity of the impression material.	Absence of total fusion between putty and light body "wash" materials.	5(3.3%)
Presence of voids on the preparation area.	Greater than 1 millimeter voids but there are not situated on the cervical margin of the tooth preparation	18(12%)
Presence of tissue over the cervical margin of the tooth preparation.	Absence of flash beyond the cervical margin.	6(4%)
Presence of blood contamination on the crown and bridge impression.	Presence of coagulant, blood, or food debris surrounding the cervical margin of the tooth preparation.	79(52.2%)
Absence of Maximum Intercuspatation in the closed-mouth impression technique.	Absence of thinning of dental impression material over the occlusal contacts of the recorded teeth.	2(1.3%)
Absence of unprepared teeth stops in the closed-mouth impression technique.	There are no unprepared teeth anteriorly and posteriorly to the abutment teeth.	1(0.6%)
Lack of complete registration of canine teeth in the closed-mouth impression technique.	Absence of complete registration of upper and lower cuspids.	2(1.3%)

Table 4. Frequency of the fixed prosthodontic prosthesis requested

The fixed prosthodontic restoration requested	Frequency (No. (%))
Metal-ceramic fixed dental restoration	80(53.3%)
Zirconia-based fixed dental restoration	40(26.6%)

Lithium disilicate (E-max) restoration	10(6.7%)
All-metal fixed dental restoration	15(10%)
Others	5(3.7%)

Table 5. Frequency of the used impression tray

The used the impression tray	Frequency (No. (%))
Custom-made impression tray	2(1.3%)
Metal dual-arch impression tray	1(0.6%)
Metal single-arch impression tray	11(7.3%)
Plastic dual-arch impression tray	2(1.3%)
Plastic single-arch impression tray	134(89.3%)

We have evaluated 150 crown and bridge impressions. As it has been shown in the previous tables overall, a defect was detected in 109(72.6%) of the evaluated fixed dental prosthesis impressions. Tissue over the finish line was seen in 71(47.3%), absence of unprepared stops in closed-mouth impressions 13(8.6%), the impression tray pressure on the soft tissue 18(12%), cervical margin air bubble or voids 86(57.3%), and exposure of the impression tray via the occlusal or incisal edges 44(29.3%). Table 4 reveals the fixed dental restorations requested by the dentists. The majority of the requested fixed dental restorations were metal-ceramic restorations 80(53.3%) and zirconia oxide-based fixed dental prostheses 60(40%). Table 5 reveals the information regarding the type of used impression trays for taking the fixed dental prosthesis impression. The plastic stock impression trays were the most commonly used type 134(89.3%).

4. Discussions

Supplying the lab technician with an appropriate negative replica of the teeth and surrounding structures of a fixed prosthodontic patient is an essential aspect for successful fixed restoration and it is important to evaluate the fixed prosthodontic impressions prior to transferring them to the lab technician.

The most important aspect of the crown and bridge impression is the fine details of the cervical margin of the prepared abutment teeth. To avoid improper fit of the fixed dental restorations, the fine details of the cervical margin must be recorded in the impression. In the current study, 91(60.6%) of the evaluated sample showed air bubbles at the cervical margin of the tooth preparation and for this reason care must be taken to avoid entrapment of air during mixing and loading of the dental impression material. Voids in our study were seen in 42(28%) of fixed dental prosthesis impressions assessed. Out of 150 examined fixed prosthodontic impressions in this study, only 8(5.4%) of them showed fold in the cervical finish line. These folds are caused because of the impression material has pasted its working time or because the impression material has failed to adapt to the prepared abutment teeth. When the preparation margins extend subgingivally, the adjacent gingival tissues must be displaced laterally to allow access and provide space for adequate impression material thickness. This may require enlarging the gingival

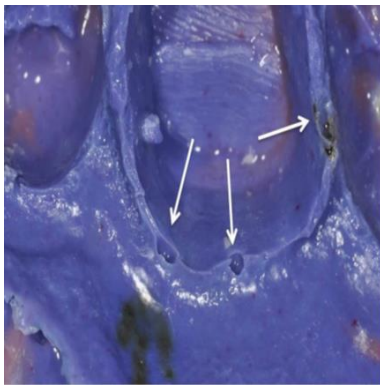
sulcus through mechanical, chemo-mechanical or surgical means, it must be done without jeopardizing periodontal health. Chemical-mechanical method of gingival tissue retraction is the most universal method of gingival retraction. It is achieved by the use of a chemically impregnated cord. The cord will push the gingiva mechanically while, the chemicals which have astringent action will stop bleeding from the gingival tissue. By combining chemical action with pressure packing, enlargement of the gingival sulcus as well as control of fluids seeping from the walls of the gingival sulcus is more readily accomplished. Only 3(2%) and 6(4%) of the examined impressions showed the presence of tear in the cervical margin of the tooth preparation and tissue over the cervical margin respectively. Inadequate gingival tissue retraction can cause improper recording of the cervical margin of the tooth preparation. In our survey, 55(36.6%) of the fixed prosthodontic impression evaluated had adequate gingival tissue displacement. 89(59.3%) of impression evaluated showed defects in the area of tooth preparation. Air bubbles 40(26.6%) followed by voids 18(12%) were the most common defects in this area. The gingival tissue retraction must create clean and dry field free from serum seepage or blood. The disinfection of fixed prosthodontic impressions is an essential procedure to prevent the spread of microbial cross-contamination from the patient in the fixed prosthodontic clinic to dental laboratory technicians. Rinsing of the impression should be performed with water to remove traces of saliva and any debris, and then chemically disinfected. Blood was found in 79(52.2%) of the fixed prosthodontic impressions evaluated. Irreversible hydrocolloid impression material should be used only for the opposing dental arch and for fabrication of provisional restorations but not for making final impression for the definitive fixed dental prostheses as it is not accurate enough for this purpose. Addition silicones are considered to be the dental impression materials of choice for crown and bridge work, but unfortunately in the current study only 9(6%) of the impression sample were made by addition silicone rubber base impression material. The result of our survey revealed that out of 130 rubber base impressions, 28(18.6%) were two-step techniques and 102(68%) was the one-step technique. 13(8.7%) of impressions evaluated showed exposure of the putty or heavy body impression material. this may result due to lack of uniform space for the wash impression material. Closed-mouth (dual-arch) impressions accounted for only 3(1.9%) of the entire study sample. When used correctly, the closed-mouth final impression results in the production of accurately fitting fixed dental prostheses with the reduction of the cost and time to the dental practitioners.

The success or failure of the fixed prosthodontic impressions depends on the correct selection of size, shape, and rigidity of the impression tray. Unfortunately, most of the dentists use the cheaper pre-fabricated plastic impression trays due to the time and cost associated with the construction of special resin impression trays because many dental practitioners have no awareness of the drawbacks associated with the use of these plastic stock impression trays. In the present study 136(90.6%) of impressions were made using a plastic tray.

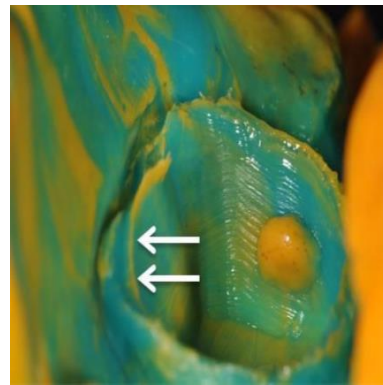
The following are some reasons for The increased frequencies of the inappropriate crown and bridge impressions received by the lab technicians may be related to the following reasons: Absence of awareness and practice, paying no care to the fine details, inaccurate handling of the dental impression material, paying no attention to the fine details, pre-mature removal of the fixed dental prosthesis impressions prior to complete polymerization due to ignoring the time of polymerization specified by the manufacturer, and the absence of knowledge on the need for self-assessment.

Dental practitioners with less than 10 years of experience have shown an increase percentage of errors occurring in elastomeric impression technique with a significant difference. In this study, there was no significant association between errors in the preparation area and in the finish line and dental practitioner's gender or experience years.

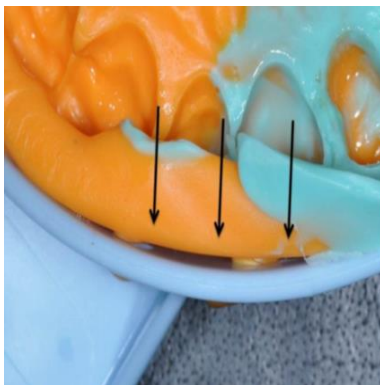
The following are some examples of the errors that found in the fixed prosthodontic impressions: (Errors are indicating by the arrows): a) cervical margin air bubbles\voids. b) Lack of the Wash Material. c) Inadequate adhesion of the impression material to the tray. d) Pressure of impression tray on soft tissue. e) Tray, Show Through of Occlusal/Incisal Edges. f) Material, Void on Preparation. g) Material, Lack of Polymerization (Undisturbed material). h) Gingival Displacement, Tissue over Finish Line. i) Gingival Displacement, Blood on Impression. j) Dual Arch, Lack of maximal inter-cuspal position. k) Dual Arch, Unprepared Stops. l) Dual Arch, Canine Recorded.



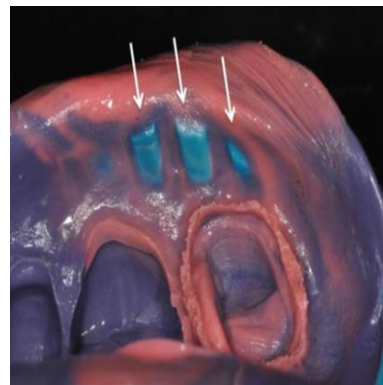
(a) Finish line errors (Finish Void/Bubble)



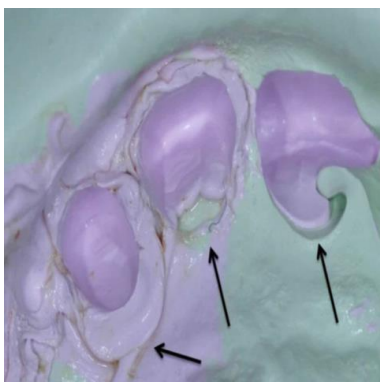
(b) Finish Line, Lack of Wash Material



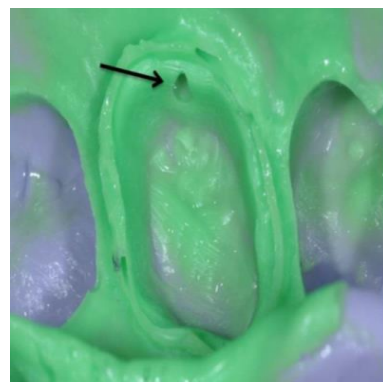
(c) Inadequate retention of impression to the impression tray



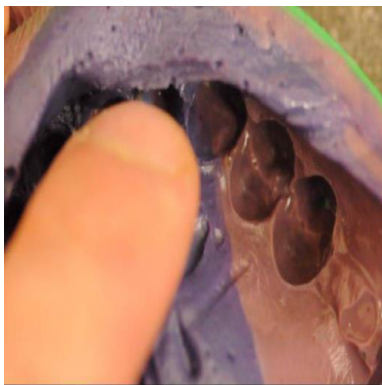
(d) Pressure of the impression tray on the soft tissue



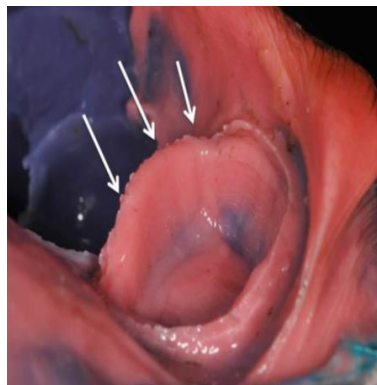
(e) Tray, Show Through of Occlusal/Incisal Edges



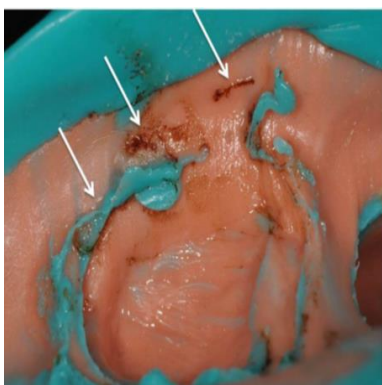
(f) Material, Void on Preparation



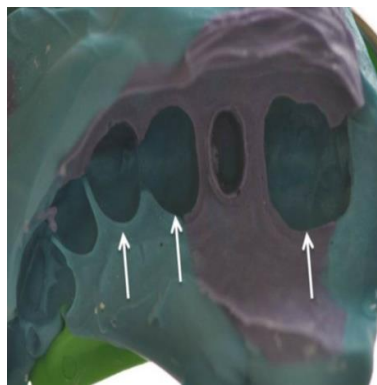
(g) Material, Lack of Polymerization (Undisturbed material)



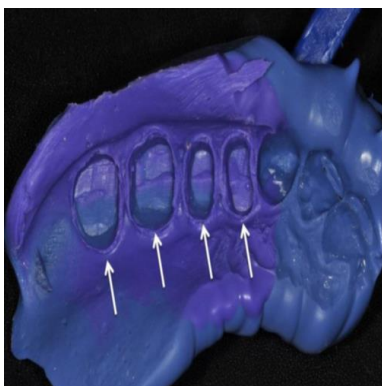
(h) Gingival Displacement, Tissue Over Finish Line



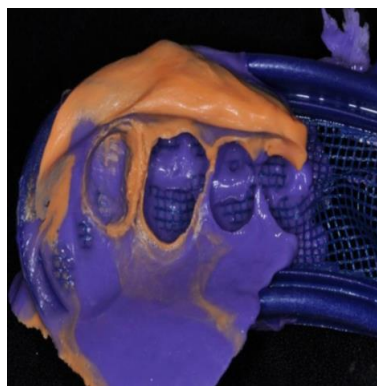
(i) Gingival Displacement, Blood on Impression



(j) Dual Arch, Lack of maximal inter-cuspal position



(k) Dual Arch, Unprepared Stop



(l) Dual Arch, Canine Recorded

5. Conclusions

It has been found that the qualities of final fixed prosthodontic impressions received at the visited commercial dental labs were unacceptable which can lead to poor fitted crown and bridge restorations cemented in the patient mouth. The dentists should self-assess the fixed prosthodontic impressions before sending them to the dental laboratories. This can be improved and updated by attending fixed prosthodontic courses to increase the awareness and skills on recent dental materials.

Declarations

Source of Funding

This study did not receive any grant from funding agencies in the public or not-for-profit sectors.

Conflict of Interest

There are no conflicts of interest.

Consent for Publication

The author declares that he consented to the publication of this study.

Acknowledgements

The author is grateful to the owners of the Commercial Dental Laboratories and their staff members where the impressions sample have been obtained.

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